**Investigating the Templating Effect of Hydrogen Clathrate Hydrates**

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As water contacts hydrogen gas at sufficiently high pressures and low temperatures, the thermodynamically preferred phase is a clathrate of cubic structure II (sII). sII has been shown to host one $H_2$ molecule in the small ($5^{12}$) cavity and up to four $H_2$ molecules in the large ($5^{12}6^4$) cavity, yielding an overall storage capacity of 3.8 wt.%. The available $H_2$ in this thermodynamically stable structure falls short of the current target of 5.5 wt. % and thus other strategies must be considered. Of the known clathrate hydrate structures, many offer increased storage capacities when compared to sII. However, as sII is the most stable phase, these structures are difficult to observe using conventional formation methods. In this work we promote the growth of a metastable $H_2$ clathrate structure by utilizing the 'templating effect'. Specifically, hydrate 'seeds' of cubic structure I (sI) methane hydrate are first formed by pressurizing ice grains (< 180 µm) with $CH_4$ gas up to 100 bar at 263 K. After 3 days of formation, the sI seed hydrate is pressurized with $H_2$ gas up to 700 bar for 24 hours at 258 K. Cryogenic Raman spectroscopy and powder X-ray diffraction performed on the final clathrate sample revealed the presence of $H_2$ molecules in new environments, which are suggested to be in the cages of sI hydrates. These results show proof-of-concept that the synthesis pathway of $H_2$ hydrates may be altered in such a way that a desired final structure may be 'templated' from that of a seed hydrate. Results investigating the effect of templating time as well as initial seed hydrate structure will be also discussed.